Amendments to the Claims

1. (Currently Amended) A rotary module for implementing a pressure swing adsorption process having an operating pressure cycling between an upper pressure and a lower pressure for extracting a first gas fraction and a second gas fraction from a gas mixture including at least the first and second gas fractions, the rotary module comprising:

a stator including a first stator valve surface, a second stator valve surface, a plurality of first function compartments opening into the first stator valve surface, and a plurality of second function compartments opening into the second stator valve surface;

a rotor rotatably coupled to the stator and including a first rotor valve surface in communication with the first stator valve surface, a second rotor valve surface in communication with the second stator valve surface, a plurality of flow paths for receiving adsorbent material therein, each said flow path including a pair of opposite ends, and a plurality of apertures provided in the rotor valve surfaces and in communication with the flow path ends and the function ~~ports~~ compartments for cyclically exposing each said flow path to a plurality of discrete pressure levels between the upper and lower pressures for the pressure swing adsorption process; and

a gas mixing means in communication with at least two function ~~ports~~ compartments for mixing a relatively higher pressure gas flow with a relatively lower pressure gas flow to effect a let-down of pressure in the relatively higher pressure gas flow, while providing a source of reduced pressure or vacuum to the relatively lower pressure gas flow.

2. (Currently Amended) A rotary module for implementing a pressure swing adsorption process having an operating pressure cycling between an upper pressure and a lower pressure for extracting a first gas fraction and a second gas fraction from a gas mixture including the first and second gas fractions, the rotary module comprising:

a stator including a first stator valve surface, a second stator valve surface, a plurality of first function compartments opening into the first stator valve surface, and a plurality of second function compartments opening into the second stator valve surface;

a rotor rotatably coupled to the stator and including a first rotor valve surface in communication with the first stator valve surface, a second rotor valve surface in communication with the second stator valve surface, a plurality of flow paths for receiving adsorbent material therein, each said flow path including a pair of opposite ends, and a plurality of apertures provided in the rotor valve surfaces and in communication with the flow path ends and the function ~~ports~~ compartments for cyclically exposing each said flow path to a plurality of discrete intermediate pressure levels intermediate the upper and lower pressures for releasing gas from or supplying gas to the flow paths so as to perform the pressure swing adsorption process; and

a gas expander for pressure letdown of gas released from or supplied to ~~a flow path~~ at least one of said flow paths at an intermediate pressure level, and for recovery of mechanical power from the pressure letdown.

3. (Previously Presented) The rotary module according to claim 1 wherein the gas mixing means is an ejector or a jet pump.

4. (Currently Amended) The rotary module according to claim 1, wherein ~~each flow path includes an adsorber comprising~~ said adsorbent material in each flow path comprises at least one adsorbent sheet.

5. (Previously Presented) The rotary module according to claim 1, wherein the function compartments are configured to provide substantially uniform gas flow through the flow paths.

6. (Previously Presented) The rotary module according to claim 1, wherein the function compartments are coupled substantially adjacent to respective ends of the flow paths for implementing high frequency pressure swing adsorption.

7. (Previously Presented) The rotary module according to claim 1, wherein the function compartments are positioned a distance from respective flow path ends sufficient for implementing the pressure swing adsorption process at a rotor rotational speed of at least 20 revolutions per minute.

8. (Previously Presented) The rotary module according to claim 2 further comprising a motive means adapted to rotate the rotor relative to the stator, said motive means powered at least partially by mechanical power recovered by the gas expander.

9. (Previously Presented) The rotary module according to claim 8 wherein the motive means is selected from the group comprising an electric motor, a gas motor or a hydraulic motor.

10. (Currently Amended) The rotary module according to claim 2, wherein ~~each flow path includes an adsorber comprising~~ said adsorbent material in each flow path comprises at least one adsorbent sheet.

11. (Previously Presented) The rotary module according to claim 2, wherein the function compartments are configured to provide substantially uniform gas flow through the flow paths.

12. (Previously Presented) The rotary module according to claim 2, wherein the function compartments are coupled substantially adjacent to respective ends of the flow paths for implementing high frequency pressure swing adsorption.

13. (Previously Presented) The rotary module according to claim 2, wherein the function compartments are positioned a distance from respective flow path ends sufficient for implementing the pressure swing adsorption process at a rotor rotational speed of at least 20 revolutions per minute.

14. (Previously Presented) The rotary module according to claim 2, further comprising a gas compressor fluidly coupled to a gas stream at the lower pressure for compressing the gas stream, wherein the gas compressor is powered at least partially by the mechanical power recovered from the gas expander.

15. (Previously Presented) The rotary module according to claim 14 wherein the compressed gas stream is exhaust gas at a pressure greater than the lower pressure.

16. (Previously Presented) The rotary module according to claim 14 wherein at least a portion of the compressed gas stream is a heavy reflux gas stream.

17. (Previously Presented) The rotary module according to claim 2 further comprising a vacuum pump fluidly coupled to a gas stream at the lower pressure, for providing a source of reduced pressure or vacuum to the gas stream at the lower pressure, wherein the vacuum pump is powered at least partially by the mechanical power recovered from the gas expander.

18. (Currently Amended) A method for producing a product gas enriched in hydrogen from a petroleum refinery process gas containing hydrogen, the method comprising the steps of:

providing the petroleum refinery process gas containing hydrogen as a feed gas to a rotary module configured to implement a pressure swing adsorption process cycling between an upper working pressure and a lower working pressure, the rotary module comprising:

a stator including a first stator valve surface, a second stator valve surface, a plurality of first function compartments opening into the first stator surface, and a plurality of second function compartments opening into the second stator valve surface;

a rotor rotatably coupled to the stator and including a first rotor valve surface in communication with the first stator valve surface, a second rotor valve surface in communication with the second stator valve surface, a plurality of flow paths for receiving adsorbent material therein, each said flow path including a pair of opposite ends, and a plurality of apertures provided in the rotor valve surfaces and in communication with the flow path ends and the function ~~ports~~ compartments for cyclically exposing each said flow path to a plurality of discrete intermediate pressure levels intermediate the upper and lower working pressures for releasing gas from or supplying gas to the flow paths so as to perform the pressure swing adsorption process; and

performing a pressure swing adsorption process with the rotary module to produce a hydrogen-enriched product gas and a hydrogen-depleted exhaust gas.

19. (Previously Presented) The method according to claim 18 wherein the petroleum refinery process gas containing hydrogen is a hydrotreater process gas.

20. (Previously Presented) The method according to claim 19 wherein the hydrogen-enriched product gas is recycled for further use in a hydrotreater.

21. (Previously Presented) The method according to claim 19 wherein the hydrogen-depleted exhaust gas is delivered to a refinery fuel gas header.

22. (Previously Presented) The method according to claim 21 wherein the hydrogen-depleted exhaust gas is delivered to the refinery fuel gas header at a pressure elevated above atmospheric pressure.

23. (Previously Presented) The method according to claim 22 wherein the lower working pressure of the pressure swing adsorption cycle is elevated above atmospheric pressure.

24. (Previously Presented) The method according to claim 21 wherein the hydrogen-depleted exhaust gas is delivered to the refinery fuel gas header at the lower working pressure of the pressure swing adsorption cycle, which is elevated above atmospheric pressure to approximately the operating pressure of the refinery fuel gas header.

25. (Previously Presented) The method according to claim 18 wherein:

the rotary module further comprises an exhaust gas compressor; and

the hydrogen-depleted exhaust gas is compressed by the exhaust gas compressor to an exhaust gas pressure greater than the lower working pressure of the pressure swing adsorption cycle.

26. (Previously Presented) The method according to claim 25 wherein the hydrogen-depleted exhaust gas is delivered to a refinery fuel gas header following compression by the exhaust gas compressor.

27. (Previously Presented) The method according to claim 26 wherein the petroleum refinery process gas containing hydrogen is a hydrotreater process gas.

28. (Previously Presented) The method according to claim 27 wherein the hydrogen-enriched product gas is recycled for further use in a hydrotreater.

29. (Currently Amended) The method according to claim 25 wherein the exhaust gas compressor is a free rotor compressor or a turbocompressor powered at least partially by energy recovery from the expansion of gas released from or supplied to ~~a flow path~~ at least one of said flow paths at an intermediate pressure of the pressure swing adsorption cycle.

30. (Previously Presented) The method according to claim 29 wherein the hydrogen-depleted exhaust gas is delivered to a refinery fuel gas header following compression by the exhaust gas compressor.

31. (Previously Presented) The method according to claim 30 wherein the petroleum refinery process gas containing hydrogen is a hydrotreater process gas.

32. (Previously Presented) The method according to claim 31 wherein the hydrogen-enriched product gas is recycled for further use in a hydrotreater.

33. (Previously Presented) The method according to claim 29, wherein the gas used to power the turbocompressor or free rotor compressor comprises at least a countercurrent blowdown gas.